ABSTRACT: An apparatus having a frame adapted to move in a longitudinal direction over the surface of a road or the like upon which mixed materials are to be spread. The frame mounts a transversely oriented chamber which is provided with a pickup opening and a discharge opening at its opposite extremities. A mixing means in the chamber is operative to pull into the chamber materials arranged in a windrow upon the road surface. The mixing means also is operative to lift and thrust the materials transversely and inwardly through the chamber in a generally suspended state. The discharge opening permits the mixed materials to be deposited on the road surface, and a spreading means on the frame rearwardly of the chamber is arranged to spread the deposited materials transversely and outwardly.
APPARATUS FOR MIXING AND SPREADING ROAD BUILDING MATERIALS OR THE LIKE

BACKGROUND OF THE INVENTION
1. Field of the Invention
The present invention relates to apparatus for mixing and spreading road building materials or the like.

2. Description of the Prior Art
In the construction of roadways or the like it has been the usual practice to utilize a high production rate automatic road trimmer or grading machine to spread and grade previously mixed road building materials deposited on the road grade ahead of the grading machine in a winnow or windrow. The mixers used to mix the materials were unable to keep up with the high production rate of the grading machine and consequently the job production pace was very slow compared to the pace of which the grading machine was capable. In addition, the mixture of such materials by prior art mixers was not always as complete and as consistent as it should be.

SUMMARY
According to the present invention one or more transversely oriented chambers are attached to an automatic grading machine of the prior art to receive and mix road building materials for discharge onto the road grade. Mixing means in each chamber are operative to receive the materials to be mixed, and are further operative to lift and thrust said materials transversely and inwardly in a generally suspended state to achieve very efficient mixing and minimize frictional drag of the materials upon the interior surfaces of the chamber. The inlet and outlet openings of the chamber are transversely spaced apart so that the materials necessarily undergo transverse movement from receipt to discharge. After passage out of the discharge opening, the materials undergo an opposite transverse movement by virtue of the spreading action of a spreader mounted rearwardly of the discharge opening. The continuous travel and reversal of movement provides greatly improved uniformity of mixing compared to that of the prior art.

With this arrangement, prespread windrows of aggregate and cement, for example, can be lifted into the outer extremities of a pair of mixing chambers and uniformly mixed together and with water introduced into the chambers by a suitablemetering system. While being mixed, the materials are transported toward the inner extremities of the chambers at the center of the machine so that a helicoid screw spreader or the like can then spread the deposited material evenly over the grade.

Such a system eliminates any need for separate mixers and effects material mixture at a rate consistent with the relatively high production rate of modern automatic grading machines. Moreover, attachment of the present mixing apparatus to such an automatic grader greatly increases the productivity and versatility of such a machine, enabling it to be more fully employed in the various phases of road building.

Various modifications and other objects and features of the invention will become apparent from consideration of the following description taken in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of an automatic grading machine incorporating the mixing apparatus of the present invention;

FIG. 2 is a front elevational view of the mixing apparatus of FIG. 1, most of the showing of the grading machine being omitted for brevity and clarity;

FIG. 3 is an enlarged view taken along line 3–3 of FIG. 2;

FIG. 4 is an enlarged view taken along line 4–4 of FIG. 3;

FIG. 5 is an enlarged view taken along line 5–5 of FIG. 3;

FIG. 6 is an enlarged view taken along line 6–6 of FIG. 3;

FIG. 7 is a view taken along line 7–7 of FIG. 6;

FIG. 8 is a view taken along line 8–8 of FIG. 3;

FIG. 9 is a view taken along line 9–9 of FIG. 5; and

FIG. 10 is a view taken along line 10–10 of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS
Referring now to the drawings, there is illustrated an apparatus 10 for mixing and spreading road building materials. The mixing apparatus is particularly adapted for use in conjunction with commercially available road trimmers or grading machines, such as the grading machine 12 illustrated in FIG. 1. That is, it is contemplated that the present apparatus 10 could be utilized with a frame adapted for longitudinal movement along the length of the surface upon which mixed materials are to be spread, but as a practical matter attachment of the apparatus 10 to an existing grading machine 12 produces very acceptable results.

In this regard, a common form of automatic road trimming or grading machine 12 includes a generally rectangular frame 14 which is supported upon crawler treads 16 at its four corners. The frame 14 normally mounts a transversely oriented front auger and strike-off bar (not shown) which are used in a grading operation. However, as will be seen, this front auger and strike-off bar are preferably automatically controlled in elevation by the same control system which normally controls the elevation of the auger and strike-off bar. For this reason, the present mixing apparatus 10 can be controlled in elevation with the same precision which characterizes the elevation of the replaced grader components.

The grading machine frame 14 also mounts a transversely oriented spreading means in the form of a helicoid auger mounted on a transverse shaft 18 located rearwardly of the apparatus 10 and just ahead of a transversely extending strike-off or leveling bar 20. As is well known to those skilled in the art, the helicoid spreader is characterized by blades having material spreading surfaces which are operative to engage material lying on the roadbed at the center of the machine 12, and transversely spread such material outwardly toward the sides of the machine 12. The elevation of the helicoid spreader mounted on the shaft 18 is automatically controlled by suitable sensors and associated control means (not shown) which are a part of the commercially available grading machine 12.

The machine 12 is also characterized by suitable drive means (not shown) which are capable of moving the frame 14 longitudinally and forwardly over the road surface 22 upon which the road materials are to be spread. As will become apparent, the present invention is primarily concerned with the apparatus 10 for receiving and mixing road materials for discharge and subsequent spreading upon the roadbed, and any suitable vehicle can be used which is capable of pulling or driving the mounting frame 14 for the apparatus 10 longitudinally over the roadbed 22. Moreover, the present mixing apparatus 10 is adapted for mixing materials for use in constructing airport runways, canals, and similar applications other than roadbeds, the reference to road building and road building materials being simply by way of example.

As previously indicated, the attachment of present mixing apparatus 10 to the commercially available grading machine 12 greatly improves the utility of the grading machine, while also speeding the mixing operation so that the mixing and spreading operations occur at the same rate, and at the high production rate of the machine 12.

The apparatus 10 is particularly useful in mixing cement treated base material, which comprises aggregate, cement, and water. The materials are customarily arranged in two windrows 24 by trucks or usual spreader boxes. Generally the aggregate is spread in windrows first, and the cement is placed in an overlying layer on the windrows by hand or by any other suitable method.

The mixing apparatus 10 comprises, generally, the frame 14, and a pair of elongated, transversely extending material receiving and mixing chambers 26 arranged in end-to-end
relation. Each chamber 26 includes a receiving or pickup opening 28 adjacent its outer extremity and a discharge opening 30 transversely spaced from the opening 28 and located at the inner extremity of the chamber. In addition, the apparatus 10 includes transversely extending means in the form of an elongated shaft in each chamber 26 and mounting a plurality of radially extending arms 32, each of the arms 32 mounting an inclined blade or paddle 34. As will be seen, the inclination of the paddles 34 is operative to engage the material of the windrows 24 to lift and thrust the material transversely through the mixing chamber and toward the discharge opening 30, said passage onto the road surface just forward of the rear screw or auger mounted on the shaft 18. The auger spreads the materials transversely in the opposite direction that is, toward the pickup openings 28, so that from the time the materials are picked up until the time they are discharged and spread, such materials undergo reversion in direction which is accompanied by internal shearing and mixing.

The particular construction and arrangement of these components will next be described.

Each mixing chamber 26 is generally cylindrical or drum-shaped in configuration, being closed at the ends by end walls 36 and 38. As best viewed in FIGS. 3 and 4, the pickup opening 28 extends approximately half the length of the associated chamber 26 and is defined at its lower terminus by a forward extending ramp 40. The portions of the chamber 26 which define the opposite sides of the pickup opening 28 pivotally mount a pair of wingwalls or drift wings 42 and 44 which extend out in front of the pickup opening 28 and straddle the associated windrow 24. The drift wings 42 and 44 thus help to guide the windrow of material into the pickup opening 28. The interior pair of drift wings 44 are equipped with flights 46 to prevent the drift wings 44 from cutting into the subgrade or road surface 22.

Each of the discharge openings 30 is generally crescent shaped, as best seen in FIG. 5, and a part of each end wall 38 is cut away, as best viewed in FIG. 3 at 48, to enable the material discharged from both of the mixing chambers 26 to merge into a single discharge windrow at the center of the machine 12. As previously indicated, this single windrow of mixed material is further mixed by the action of the rear screw or auger of the grading machine 12, as the auger spreads the material transversely outwardly over the roadbed 22.

As the apparatus 10 is moved forward or longitudinally of the roadbed 22 by the drive means of the machine 12, the windrows 24 are moved by the drift wings 42 and 44 into the pickup openings 28.

As best seen in FIGS. 3, 4, and 5, the shafts or arms 32 are rigidly keyed and clamped to a transverse mixing chamber shaft 50, each arm 32 along the length of the shaft 50 being rotated 90° with respect to the preceding arm 32. Moreover, each flat plate-like paddle 34 is oriented at an angle of approximately 45°. With the shafts 50 rotating in the normal direction indicated by the arrow 52 in FIG. 4, the paddles 34 move rearwardly in the lower portion of their rotational travel, and the inclination of the paddles 34 is such that windrow materials 24 engaged by the paddles 34 are lifted off the ramps 40 and thrust upwardly and transversely inwardly toward the center of the machine 12 by the paddles 34. As will be seen, the speed of rotation of the paddles 34 is such that the material lifted off the ramps 40 is substantially suspended away from the inner surfaces of the chambers 26 by the rapid flailing action of the paddles. This is an important feature of the invention in that the road building materials are not allowed to pile upon the ramps 40, and thereby induce undesirable drag, but instead are lifted and maintained in a generally suspended state for low-drag transport toward the discharge openings 30. Such lifting and supporting action by the paddles 34 is enhanced by making the paddles 34 sufficiently wide that the path of rotation of each paddle overlaps the corresponding path of rotation of the next adjacent paddle by, for example, 3 inches. In this regard, typical dimensions for the apparatus 10 when used in conjunction with a grading machine 12 having a span of approximately 25 feet are as follows: length of each chamber 26 is approximately 12 feet; diameter of the mixing chamber 26 is approximately 3 feet; width of inlet opening is approximately 4 feet; width of discharge opening is approximately 3½ feet; and the shaft 50 is rotated at approximately 400 feet per minute so that the tip speed of the paddles 34 is approximately 1200 feet per minute. A tip speed of 1200 feet per minute to 1600 feet per minute provides optimum results, but the tip speed will obviously vary as the other parameters are varied. Approximately thirty-four paddles 34 are used in each chamber 26, their overlapping relation creating a screwlike effect in which the road building materials are thrust from one paddle to the next to obtain both shearing with little wear on the paddles 34 or on the interior surfaces of the associated chamber 26. The inclined relation of the paddles 34 provides a turning effect which folds or internally shears the building material at right angles to the angle of entry of the material into the pickup openings 28.

It has been found that by increasing the tip speed of the paddles 34 to the point where the materials being mixed are substantially suspended within the mixing chamber 26 greatly reduces the amount of power required to effect the mixing action. That is, much more power was required in the prior art where the mixing occurs by a churning, raising and falling of a solid mass of material resting upon the bottom of a mixing chamber or resting upon the roadbed, where the roadbed forms the bottom of the mixing area.

Water is sprayed upon the materials being mixed in the chamber 26 as such materials pass transversely toward the discharge opening. The water emanates from a plurality of spray heads which are transversely spaced apart along the upper surface of the associated chamber 26, as best seen in FIGS. 4, 5, and 9. The spray heads are preferably configured to direct streams of spray 56 in opposite, generally transverse directions, as seen in FIG. 9. The spray heads 54 are supplied with water through suitable conduits 58 connected to surge tanks (not shown) on either side of the grading machine 12. The surge tanks can be filled by water trucks that run ahead of the grading machine 12, and the flow of water through the spray heads 54 is controlled or varied by water meters (not shown) in accordance with the volume of road building materials which are being mixed.

The mixing shaft 50 in the preferred embodiment of the invention is secured in position, adjustable in elevation, and driven by the same motors, gears, and assembly which is normally used on the grading machine 12 to control the front screw or auger (not shown) which was replaced by various components of the mixing apparatus 10. Summarized generally, the inner ends of the mixer shafts 50 are rotatably carried by a pair of bearings 60 and 62. FIGS. 2 and 3, which in turn are secured to the opposite sides of a support plate 64. The plate 64 in turn is coupled to the rod of a double-acting hydraulic cylinder 66 suspended from the center of the frame 14. Similar double-acting cylinders 68 and 70 are suspended from opposite sides of the frame 14 and have their rods connected to the outer extremities of the mixing chambers 26, respectively.

The cylinders 66, 68, and 70 are actuated to raise and lower the mixing chambers 26 to therebytrace the actual subgrade and avoid contamination of the building materials constituting the windrows 24 with gouged subgrade material. Exact control of the elevation also avoids washing of the mixed and spread road building materials occasioned by riding too high above the subgrade or road surface 22.

Although not shown in detail, since the sensing system already forms a part of the prior art grading machine 12, the sensing system is actuated by a pair of slods 72, one of which is shown in FIG. 1, which trail behind the drift wings 44 upon chains 74. As the slods 72 move upwardly and downwardly, they effect movement of a system of linkages 76 which cause the elevation control system (not shown) of the machine 12 to actuate the cylinders 66, 68, and 70 correspondingly.
Vertical movement of the outer extremity of each of the chambers 26 is guided by a plate 78 which is vertically slidable between a pair of ways 80. Each plate 78 is secured to the upper extremity of a depending support casing or arm 82 whose lower extremity rotatably mounts the outer end of the associated mixer shaft 50. Each arm 82 is hollow and forms a casing for a driven sprocket 84 mounted to the associated drive shaft 50, a sprocket 86, and a connecting drive chain 88. The sprocket 86 is carried by an output or drive shaft which rotatably extends through the plate 64 and is driven by a motor 90. Rotation of the output shafts effects rotation of the mixer shafts 50.

The pair of motors 90 ride up and down with the plates 78 to which they are mounted, sliding upwardly and downwardly through slots 92 provided in the sides of the frame 14.

Summarizing the operation of the apparatus 10, the windrows 24 of road building materials are spread ahead of the grading machine 12 in longitudinally extending rows spaced apart to coincide with the spacing of the pickup openings 28. Forward longitudinal movement of the grading machine 12 moves the drift wings 42 and 44 against the windrows 24, guiding the material on the ramps 40 of the pickup openings 28. In the lower portions of their paths of rotation, the paddles 34 sweep rearwardly across the pickup openings 28 and lift the material of the windrows 24 upwardly into the mixing chamber 26 where it is mixed with water introduced through the spray heads 54. The road building materials do not pile up and collect upon the ramps 40 because of the relatively rapid rate of rotation of the paddles 34, and consequent rapid rate of material removal from the ramp areas.

After introduction of the sand, gravel or aggregate, and cement into the chambers 26, the materials are transported transversely and inwardly by the canted or inclined paddles 34. At the center of the machine 12, the mixed material leaves the chambers 26 through the discharge openings 30. The mixed material deposited upon the roadway 22 is then engaged by the spreading surfaces of the usual back screw or helicoid spreader mounted on the shaft 18, and are distributed transversely toward the sides of the grading machine 12. The rear moldboard or strike-off bar 20 strikes off the material evenly, leaving a precisely mixed and spread cement treated base.

It will be apparent that instead of removing the usual front auger of the grading machine 12 to accommodate the mixing apparatus 10 in its place, the mixing apparatus 10 could, alternatively, be mounted at the forward portion of the grading machine 12. This would necessitate employment of additional equipment and controls for varying the elevation of the mixing apparatus 10 according to the grade, but it would also permit more rapid change over of the grading machine 12 from a purely grading function to a mixing and spreading function, thereby greatly increasing the use factor of the machine.

Another alternate arrangement contemplated by the present invention is the picking up by the apparatus 10 of a windrow of aggregate only, with the cement being introduced separately through an opening (not shown) provided in the outer extremity of each of the chambers 26. It will also be apparent that all of the aggregate, cement, and like road building materials being mixed could be introduced into the chambers 26 through suitable openings instead of picking up windrows of such material. However, the picking up of the material from the roadway itself appears to be the most practicable arrangement.

Although the strength of the road building structure constructed through the use of the present mixing apparatus 10 can be established only after extended periods of service, conventional titration tests of cement treated base material prepared with the apparatus 10 indicate that the uniformity and consistency of mixing is as good and generally better than similar materials prepared by the mixing equipment of the prior art.

Various modifications and changes may be made with regard to the foregoing detailed description without departing from the spirit of the invention.

I claim. 1. Apparatus for mixing and spreading road building materials, said apparatus comprising:

a frame adapted for longitudinal forward movement over the road surface upon which said materials are to be spread;
an elongated, transversely extending material receiving and mixing chamber carried by said frame, said chamber including a pickup opening and a discharge opening transversely spaced in relation to said pickup opening;

transversely extending mixing means rotatable in said chamber and including material mixing surfaces operative to engage road building materials passing into said pickup opening, said mixing surfaces being oriented to lift and thrust said material transversely toward said discharge opening for passage therethrough and onto said road surface;

and transversely arranged spreading means rotatably carried by said frame rearwardly of said discharge opening, said spreading means including material spreading surfaces operative to engage road building materials on said road surface adjacent said discharge opening, said spreading surface being oriented to spread said materials transversely and toward said pickup opening whereby said materials undergo transverse displacement and an accompanying internal shearing and mixing action during the period said materials are received in said chamber and are spread across said road surface.

2. Apparatus according to claim 1 wherein said pickup opening is located adjacent the outer extremity of said chamber in position for alignment with a longitudinally oriented windrow of road building materials, and wherein said mixing surfaces are operative to sweep across said pickup opening in a rearward direction whereby said windrow of materials is pulled into said chamber prior to picking up said materials adjacent said pickup opening.

3. Apparatus according to claim 2 wherein said pickup opening is defined in part by a ramp on the underside of said chamber and across which said windrow of road building materials is carried by said mixing surfaces, said ramp being transversely oriented and located approximately below the most forward point of the path of rotation of said mixing means.

4. Apparatus according to claim 3 and including a pair of drift wings at the sides of said pickup opening and arranged in forwardly divergent relation to guide road building materials into said pickup opening.

5. Apparatus according to claim 4 and including skids located at the forward extremities of said drift wings and adapted to ride upon the roadway to raise and lower said forward extremities in accordance with the grade of said roadway.

6. Apparatus according to claim 3 and including a skid sensor located for travel upon the surface of the roadway, and further including elevation control means coupled to said skid sensor and connected to said frame and to said chamber, said elevation control means being responsive to changes in elevation of said skid sensor to correspondingly change the elevation of said chamber relative to said frame whereby said ramp is located at the proper elevation for receipt of the windrow of road building materials.

7. Apparatus according to claim 1 and including drive means operative to drive said mixing means at a rate sufficiently high that said mixing surfaces maintain road building materials in said drum in a substantially suspended state during travel of said chamber, said mixing means comprising said pickup opening to said discharge opening whereby fractional drag of said materials on passing through said chamber is reduced, and improved mixing of said materials occurs.

8. Apparatus according to claim 1 wherein a pair of said material and receiving chambers are carried by said frame in end-to-end relation whereby road building materials are dischargeable from said discharge openings thereof and onto a roadway in a single windrow at the center of said apparatus for...
transverse spreading toward the sides of said apparatus by said spreading means.

9. Apparatus according to claim 1 wherein said mixing means includes a transverse mixer shaft, a plurality of transversely spaced apart arms mounted to said mixer shaft, and a corresponding plurality of paddles having material engaging surfaces inclined with respect to the longitudinal axis of said mixer shaft.

10. Apparatus according to claim 9 wherein the paths swept by adjacent said paddles during their rotational travel overlap.

11. Apparatus according to claim 9 wherein the angle of inclination of said paddles is approximately 45°.

12. Apparatus according to claim 9 and including drive means operative to drive said mixer shaft at a rate sufficiently high that the tip speed of said paddles is in excess of 1200 feet per minute thereby to maintain road building materials in said chamber in a substantially suspended state.

13. Apparatus according to claim 1 and including spray means in said chamber operative to add liquid to road building materials in said chamber.